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Teaching of Science Process Skills in Thai Contexts: Status, Supports and Obstacles

Nantarat Kruea-In [a]* and Orawan Thongperm [a]

[a] *Faculty of Education and Development Sciences, Kasetsart University,Kamphaeng Saen Campus, Nakhon Pathom 73140, Thailand*

Abstract

Teachers are expected to be experts of science process skills and transfer these skills to students through practical science. It was evidenced that Thai science teachers had proper performance of most science process skills. Nevertheless, in classrooms, science process skills seemed barely bound to science teaching and learning activities. Five in-service secondary school science teachers, from the Western Region of Thailand, who participated in a professional development workshop based on social constructivism for enhancing their science process skills and teaching, their performance was assessed after the workshop and revealed their performance ranged from high to highest levels. They also volunteered to participate in a follow-up study to investigate teachers' integration of science process skills into their science teaching. Data were gathered from classroom observations, interviews, and documentation. The results described each volunteer teacher's science classroom practice, this concluded Thailand's status of science process skills integration into teaching. In the core science courses, Thai teachers regularly engaged students to practical activities, however, with worry of being able to cover the contents included in the standards. Selective science courses were more responsible to promote student understandings and performance of science process skills. Supports and obstacles in integration of the skills into teaching were also discussed.

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Keywords: Science process skills, secondary science teachers, professional development, follow-up study, social constructivism;

1. Introduction

Acquisition of science process skills is essential for scientific literacy as it is one of the main learning outcomes in science, and serves as foundation for the scientific method, which scientists use to inquire about the natural world (Millar and Driver, 1987). Science teachers are expected to be equipped with these skills and be able to transfer to

*Corresponding Author: Nantarat Kruea-In. Tel.: +6-687-256-1518
E-mail address: fedunrp@ku.ac.th

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their students through science laboratory activities. In Thai science learning standards, science process skills are harmonized within all the indicators of every science learning standard, emphasized in Standard 8: The Nature of Science and Technology. According to Thai science learning standards, the science process skills consist of 13 skills. These skills are observing, classifying, measuring, using numbers, space/time relationship, inferring, predicting, communicating, controlling variables, defining variables operationally, formulating hypotheses, experimenting, interpreting data and drawing conclusions. Science courses in Thai at basic education level (Grade1-12) are divided into 2 types; the core courses and the selective courses. The core science courses are for every learner to achieve all indicators in the learning standards. The selective science courses are additional courses for learners in each school, more relevant to their needs and aptitudes or local community requirements. Schools can establish their own courses, mostly focus on science practical skills and experiences, e.g. 'Science Process Skills', 'Basic Science Projects' and 'Science Toys' courses. Many researchers [e.g. Chan, 2002; Emereole, 2009; Karsli, Şahin & Ayas, 2009) reported in-service teachers' have inadequate levels of understanding and performance of science process skills. However, in Thai contexts, it seemed to be contradictory to those of research done. From previous research (Kreua-In & Buaraphan, inpress) that Thai teachers had proper performance of these skills. However, classroom teaching seemed barely bound with these skills and resulted in a low achievement level from tests both nationally and internationally. This study aimed to investigate how Thai science teachers teach science process skills and identify the factors which support and obstruct the teachers in the integration of science process skills into teaching through a follow-up study.

2. Methodology

2.1. Participants

The participants of this study were 5 female in-service secondary science teachers, teaching students grade 7-9 (age 13-15). They were from 3 provinces (Nakhon Pathom, Ratchaburi and Petchaburi), located in the Western Region of Thailand. The 5 volunteer teachers previously participated in a social constructivist-based professional development workshop namely *'Integration of Science Process Skill into Science Teaching'* in December 2012.

2.2. Context of the Professional Development Workshop

The workshop was designed to enhance teachers' science process skills through practical activities. The workshop activities lasted 5 days and could be divided to 6 sessions, which were; 1) discuss and perform of each science process skill and to conduct scientific investigations, 2) model teaching of science process skills in accordance with the science learning standards, 3) analyze and integrate science process skills in science camp and field trip activities, 4) analye the given laboratory lesson plans and share techniques based on social constructivist teaching and learning perspectives, 5) discuss, analyze and create assessment tools for science process skills, 6) create or develop and present lesson plans, along with peer critiques and suggestions. The workshop activities were active and collaborative discussions, brainstorming, science experiments and gallery walks. Peer teaching was used several times when some teachers could not catch up with the activities. The workshop was also flexible and allowed the participant teachers to take extra time to finish some sessions. Before and after joining the workshop, all 36 participants were asked to take a Performance Test on Science Process Skills (PTSP), comprised of 26 open-ended items. Results showed that after the workshop all of the participants including the 5 volunteer teachers could perform the skills ranging from high to highest levels. Their interaction during the workshop somewhat highlighted the lack of appropriate related science concepts and intensive practical science experiences. The lesson plans created during the workshop revealed that all participants could clearly integrate the social constructivist perspectives and science process skills into science activities. At the end of the workshop all participants were asked to join a follow-up study for classroom implementation and to improve their teaching. Five volunteer science teachers were willing to cooperate.

2.3. Data Collection and Analysis

The methods of data collection utilized in this study consisted of non-participant classroom observation, semi-structured interview and documentation. According to their willingness and convenience, the methods employed were different among the five volunteer teachers. Only two of the five volunteer teachers allowed the researcher to observe how they taught in their core science courses. The interviews and documentation were employed to every volunteer teacher. The duration of each teacher's interview was approximately 60 minutes. Related documents were selected by the teachers and given to the researcher after the interviews. The details of the five volunteer secondary science teachers, including age, experiences, educational backgrounds and data collection methods, are shown in Table 1. Because this study used an interpretive research framework (Neuman, 2003), the volunteer teachers' words, meanings, actions and related documents, i.e. teachers' lesson plans, students' worksheets and workbooks, were reviewed and interpreted to describe the emergent patterns and issues related to the integration of science process skills into teaching.

Table 1. Volunteer teachers' details

Pseudonyms	Age (yrs.)	Teaching Experience (yrs.)	Educational Backgrounds	Methods*		
				O	I	D
Lalita	51	31	B.Ed.(Teaching Sc.) M.Ed.(Teaching Sc.)	✓	✓	✓
Lada	48	15	B.Sc.(Agriculture) M. Sc.(Agriculture)		✓	✓
Viranda	38	8	B.Ed.(Chemical Ed.) M.Ed.(Ed. Administration)		✓	✓
Risa	43	9	B.Ed.(General Sc.) B.Sc.(Thai Medicine)		✓	✓
Pim	39	2	B.Sc.(Agriculture)	✓	✓	✓

* Data collection methods; O: observation, I: interview, D: documentation.

3. Results

3.1. How teachers integrated science process skills into their teaching

Each volunteer teacher's integration of science process skills into their teaching is described below.

Lalita: From classroom observation, Lalita taught her students on the topic of Light and started the lesson by engaging students with several relevant daily situations. She explained the procedure steps for all activities and allowed her students, working in groups, to carry out all activities at the same time. During students participated in the practical activities, Lalita neglected to help her students to adequately measure object and image distance, when they used short rulers, measuring the distances in the midair. There were insufficient light sources, the students needed to queue to do the experiments. After giving some time for students to carry out the activities, Lalita asked them to share the results, then used the results for a whole class discussion to draw conclusions and identify possible sources of errors. During her interview she stated "I always focus on practical activities. My students always doing practical activities…which make them enjoy it". Lalita also stated that her students, mainly, performed the experiment, and interpreted the data and drew conclusions. She expressed that she usually needed to make the conclusions of the activities on behalf her students because they knew very little about science vocabularies and were lethargic in searching for information so they could not make conclusions by themselves.

Lada: Believing that enhancing students' science process skills could make them higher achievers in and attitudes towards science, Lada informed that she started integrating science process skills into teaching and learning activities more than 10 years ago. From Lada's photosynthesis lesson plan, she began the activity with asking the question that 'What factors are necessary for plant photosynthesis?'. Then she promoted a classroom discussion to identify the factors, according to students' prior ideas. She asked each group of students to select only one factor, formulate a hypothesis, search for information and design the experiment. The students had to hand in the experimental plans for teacher approval before conducting the experiment, collecting data, interpreting and concluding the results. The students also prepared posters for the summary of experiments. Then Lada used the gallery walk technique for sharing student outcomes with the whole class. Lada also stated that she could let students do only one practical activity for each science topic, because there was a lot of science content to be covered. She mentioned that in her regular teaching, for timesaving, she often explained science concepts and told her students the experimental results. Lada gave more emphasis on science process skills in the selective '*Science Project*' course taught to the 8th grade students. She allowed students to practice every skill by providing specific exercises for each process skill and trained them to design experiments relevant to given problems. Lada focused on the skills of identifying variables and formulating hypotheses because she thought these two skills were more important. In her opinion, if students could not accomplish these two skills, they would not be able to do the other parts of the experiments. She assigned students to conduct one survey project individually and one experimental project in a group of three. She took the role of a mentor; giving suggestions and motivating students to accomplish the science projects.

Viranda: Viranda noted that she always prepared materials and apparatus, and set them up in packages or lab baskets ready for students. She described her own teaching methodology that she always explained the steps of procedures, necessary techniques and information clearly, and used demonstration before allowing her students to conduct the activities. She also needed to help her students conclude the results. Her reason for doing this was that there was not enough time because of occasional activities (e.g. holy days and community events) which often diminished her class periods. The lesson plan gathered from Viranda on the topic of Vitamins, Minerals and Water, was extraordinary because she intended to extend the students investigation activity, which is special, because most of the time she tells students what to do, and it consumes more time than the usual activity. From the plan, students were asked to select factors that cause a loss of Vitamin C, and design experiments. She asked students to do an investigation starting with identifying the variables, formulating hypotheses, designing the steps of the procedure, doing the experiment, collecting and analyzing the data and drawing conclusions. She also taught the "Research & Knowledge Formation" courses, designed only for the world-class school curriculum. These courses required students to pose problems, do projects or search for information to answer the problems and present what they had learned. However, Viranda noted she was unsatisfied with the outcomes of her students. This was consistent with other student project reports that stated students could not identify correct variables or clearly describe the steps of experiments. Furthermore, no hypotheses and conclusions were written. Viranda pointed out that she strived to motivate students during science activities.

Risa: Risa described her own classroom practice that students always participated in practical activities, discussed, shared the results and concluded the activities based on what they had found. She usually introduced students to the problems to be answered first, asked them to identify the variables, formulate hypotheses and design the experiments. On the topic of plant growth, she asked each student to conduct the planned experiment at home for one month, record the data and present the results to the whole class. She kept her students on track by constantly asking about progression. She expressed that she was always time-restricted in class. Students must be and finish their activities in a very limited time span otherwise they would needed to complete the activities after school or make-up time with additional classes. Risa was also responsible for teaching the selective '*Science Project*' and '*Local Herbs*' courses. In the '*Science Project*', she started the course with an introduction of each science process skill and assigned students to analyze how people used these skills in their occupations. She commented that this made students understand, in depth, and automatically apply the skills to their science projects. In the '*Local Herbs*' course, she emphasized the products from Thai herbs (e.g. herbal pillows for fatigue relief and herbal paper for shoe odour removal). Students formulated appropriate proportions of various kinds of herbs to be used in the products and conduct satisfaction surveys. She urged students to bring the materials, create and test the herbal products in class. This allowed her to monitor her students and give pertinent suggestions.

Prim: Prim's lesson plans were full of practical activities, because she needed to select a few of them to use whenever there was enough class time. She commented that students liked doing activities but they always had to join social activities during school days as they were in a municipal school. In the classroom observation, Prim taught students to create and modify wind vanes. She gave the students chances to perform basic science process skills comprising of observing, predicting and communicating. She also allowed her students to try their wind vanes, outside the classroom, to identify the wind direction. Unfortunately, there was too little wind so that students could not accurately specify the wind direction. Prim ended up by telling students how to use the wind vanes and summarized the lesson for them. Prim also commented that her students were not able to design experiments by themselves due to their low achievement in science. She encouraged her students to modify or make the activities easier and more productive. She said "I let my students do the activity first, during which they always try different ways of doing the experiment. I think it is their creativity. If I gave materials and asked students to design the experiment, none of them would be able to do it".

It could be inferred from the follow-up study, with the five volunteer secondary science teachers, that the status of integration of science process skills into teaching in Thailand:

- Practical science instruction in the core science courses was a combination of mainly teacher-directed activities; teacher explanation of the science concepts, experimental conclusions, and laboratory demonstration, and less student-centred activities; conducting and modifying experiments relevant to student abilities and interests. Teachers had the main aim of teaching the core courses to promote an understanding of science concepts.
- The selective science courses had an important role to intensively enhance science process skills. These courses were more productive as students could apply the skills in scientific investigations. Responsible teachers were experts in the related content areas and capable of transferring adequate understandings and performance in science process skills to students.

3.2. Supports and obstacles in the integration of science process skills into science teaching

Supports: Teachers' beliefs, attitudes, competence and teamwork

From this study, the best support for teaching of science process skills belongs to teachers' beliefs. With strong beliefs about effectiveness of science process skills, Lada, Risa and Viranda dedicated their efforts to engage students to practice and perform these skills. Risa's attitude toward students served as a basis for teacher expectation on student achievement. Positive attitudes determined how much teachers could motivate and scaffold their students to succeed. Lada's and Risa's competence in science content and skills shaped science practical activities were productive and meaningful. Risa and her colleagues also revised the science activities annually. They redesign, added or excluded some activities, improved the materials and worksheets, and developed test items together. With support, Risa had confidence in her teaching and got ready before the semester began.

Obstacles: Time constraint and Insufficiency of laboratory equipments

All five volunteer secondary science teachers mentioned time as a significant obstacle in the integration of science process skills into teaching. Students could not concentrate on accomplishing the activities in very limited period of time available. They did not have time to think about, discuss the results in depth and improve the design of the experiments. There was not sufficient equipment provided for students in Lalita's classroom, this resulted in a loss of student attention. There were also inappropriate measuring tools for the students causing errors in data collection.

4. Discussion and Conclusion

Possessing adequate understanding and performance of science process skills is regarded as a significant aspect of science learning. Engaging students in carrying out practical science activities does not help them achieve all of the learning standards required as there is a large amount of science content to cover. The blending of direct teaching, by the teachers, to provide fundamental concepts and necessary techniques, in proper arena, student conducting investigations would possibly yield a more successful learning profile (Holidays, 2006). This study described the status of in a Thai contexts evidenced by actual classroom practice. Teachers provided practical science activities for students in the core science course with a hope to help them achieve the science contents mentioned in the standards and maintain the joy of learning. The selective science courses were expected to promote the skills because there was less content but it was more relevance to students' ability and interests. Supports and obstacles found in this study were similar to those written in previous literature, however they happened regularly and were related to a Thailand context.

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